DOCUMENT RESUME

ED 262 982 SE 046 195

TITLE	Engineering Design: A Case-Study of TEC Curriculum Development. A Summary Document.
INSTITUTION	Further Education Unit, London (England).
REPORT NO	ISBN-0-946469-57-1
PUB DATE	Jul 84
NOTE	15p.
PUB TYPE	Reports - Descriptive (141)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Curriculum Development; *Design; *Engineering; *Engineering Education; Higher Education; *School Business Relationship
IDENTIFIERS	*Engineering Curriculum; *Engineering Design

ABSTRACT

The main points made in a larger case study report of Technician Education Council (TEC) curriculum development in engineering design are summarized in this document. It includes background to the setting up of a Committee for Engineering Design by TEC, with a remit to produce guidelines and model programs for a Higher National Certificate for technician designers. Because of dissention about this committee from various TEC committees, TEC agreed to monitor the progress of this new scheme. College programs were developed and approved on time, and eight colleges (mainly polytechnics) ran the programs as pilots. The processes by which the curriculum was developed and launched comprised phase one of the study; the ways in which the programs were taught, learned, and received comprised phase two. Although there were, inevitably, problems and conflicts, the pilot programs were generally successful and were well received by students and employers. The nature of curriculum, with its emphasis on design studio work, its cross-disciplinary approach, and the need to introduce computer-assisted design, posed problems for tutors and course designers. These and other problems were more or less overcome and the enterprise was generally a success. (JN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED262982

FURTHER EDUCATION UNIT

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

J.W. Mansell

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Engineering Design

A Case-Study of TEC Curriculum Development

SE 046 195

Engineering Design

A Case-Study of TEC Curriculum Development

A Summary Document

July 1984

ISBN 0 946469 57 1

© Further Education Unit (FEU) 1984

Reproduction in whole or in part of the contents of this publication is authorised for all non-commercial educational purposes, provided the source is acknowledged.
All rights reserved with regard to commercial reproduction of the contents.

FURTHER EDUCATION UNIT

Elizabeth House · York Road · London SE1 7PH · Telephone 01-928 [illegible]

Director [illegible]

Chief Officer [illegible]

Chief Education Officers
Principals of FHE Establishments
Secretaries of Regional and FE
Examining Bodies
Press and other Interested
Institutions/Individuals

Dear Sir/Madam

ENGINEERING DESIGN—A SUMMARY DOCUMENT

Enclosed is a summary of the main points made in a larger case-study report of a TEC (now BTEC) curriculum development in engineering design.
The document summarises the background to the setting up by TEC of a Committee for Engineering Design, with a remit to produce guidelines and model programmes for a Higher National Certificate for technician designers. The setting up of this Committee was not without dissension within the various TEC committees, and the success of the enterprise was far from guaranteed. Because of this, TEC agreed to the suggestion of an FEU project to monitor the progress of this new scheme.
As the summary report indicates, the college programmes were developed and approved on time, and eight colleges (mainly polytechnics) ran the programmes as pilots. The processes by which the curriculum was developed and launched comprised phase one of the study; the ways in which the programmes were taught, learned and received comprised phase two.
The summary indicates that although there were, inevitably, problems and conflicts, the pilot programmes were generally successful and well received by students and employers. The nature of the curriculum, with its required emphasis on design studio work, its cross-disciplinary approach and the need to introduce Computer Assisted Design—posed problems not only for the tutors but also for the course designers who had somehow to fit such programmes into the very firm procedures of the TEC approval system.
The full report indicates in some detail how these problems were, more or less, overcome; the attached summary shows that the enterprise was generally a success and notes that the scheme is now generally available from BTEC.
The full report is available from the FEU, but it is hoped that this summary will give busy readers a feel for the pressures, processes and conflicts that were experienced in order to design and launch a new scheme of uncertain popularity within a relatively short space of time.

Yours faithfully

Jack Mansell

JACK MANSELL
Chief Officer

ENGINEERING DESIGN

A case-study of TEC curriculum development in engineering design

Introduction

This booklet contains a summary* of the main points brought out in the FEU Report *Engineering Design—a case-study of the TEC curriculum development in engineering design*, written by Dr. Sheila Stoney of the National Foundation for Educational Research and Jack Mansell, Chief Officer of the Further Education Unit. Inevitably, many points of interest and value have had to be omitted for reasons of space. We hope, however, that this summary may stimulate readers to acquire the full report, obtainable from the Further Education Unit, Elizabeth House, York Road, London SE1 7PH.

In the compiling of this report, FEU and NFER gratefully acknowledge help received from the Technician Education Council Working Party and the colleges that participated in the study.

The Background

There has been a growing awareness in the UK of the immense economic significance of product design and that we, as a nation, need to pay much greater attention to this area generally if we are to increase our competitiveness in world markets. During the 1960s and 1970s, attempts were made to move to a partial solution via the education system; craft, design and technology (CDT) appeared in GCE syllabuses and the Moulton Report (1976) recommended that 15-20 per cent of engineering degree courses should be devoted to engineering design. But at sub-degree level, there remained a gap. Although some engineering courses may have had a design element, there was little systematic teaching.

In 1977, the Design Council, in conjunction with the various professional institutions, approached the Technician Education Council with a request that they should examine the problem. The TEC accordingly set up a Working Party under the Chairmanship of Richard Stevens, Design

*Prepared for the Further Education Unit by the Central Office of Information 1984

Manager to the then Post Office Telecommunications.

In October 1978, the Working Party produced a Consultative Document which was approved by the Technician Education Council. Entitled *The Education of Technician Designers*, it described the general background, identified various categories of engineering designer and developed a curricular philosophy for technician designers.

The document was sent in 1979 to colleges, professional bodies and industrial organisations. This consultation exercise revealed divergent views by both industry and education, but the general response encouraged the Working Party to recommend that a special committee be set up to develop guidelines and model programmes for a TEC course in design engineering: whether or not this would be acceptable to industry could only be shown by colleges mounting viable courses based on sound curriculum design.

A Committee for Engineering Design was set up in September 1980 under the Chairmanship of Dr Ewen McEwen (replaced in 1982 by Mr Wilde, Consultant to Rolls Royce). The present project was established by the Further Education Unit, with the major aim of 'recording the setting up, operation and success of a TEC curriculum committee on engineering design'. The first phase of this research, which was undertaken by the Chief Officer of FEU, documented the curricular design process from the establishment of the first TEC Working Party for Engineering Design to the commencement of the pilot programmes at eight selected colleges.

The remainder of the research was undertaken in 1983 by the National Foundation for Educational Research, and follows these courses through to the present date. Although it would not be desirable, or even possible, to attempt a detailed evaluation at this stage, it is hoped that the analysis will prove useful to other colleges contemplating similar courses and as feedback to curriculum developers. It may also be of interest to industry and the further education system generally, and could serve as a basis for deciding whether or not to extend the evaluation by way of another project.

In the course of the project, the views of the college staff, the students on the Engineering Design courses, and their employers were sought. The main issues and conclusions arising from the case study are presented below.

The Right Balance

The many aspects of design engineering make it imperative that a good balance is maintained between them all.

First of all, between the practical and the theoretical. Employers are firm that technician designers need a good grounding in draughting skills, also a sound knowledge of mechanical engineering, manufacturing processes, company products and the materials used in their manufacture. These elements form the backbone of the engineering design course.

The majority opinion of both tutors and employers was that, while a highly theoretical knowledge of engineering principles was not needed by technician designers, they should have a broad, practical grounding in engineering science and mathematics, with enough depth to support the design process. One of the main conflicts requiring resolution in the courses, therefore, was not directly between creativity and academic rigour but the frequently-raised educational argument of 'depth versus breadth' in the curriculum. Project interviews indicated that an adequate balance had been achieved in the pilot courses, although staff were aware of a need to continue the curriculum development process after the launch of the courses.

A second possible area of conflict arose between analytical and creative skills. One or two people tended to view these as 'end members of a continuum'. The more usual opinion, however, was that analytical skills and creativity were inextricably linked in the design process. Some perceived 'good creative design' to be the outcome of well-developed analytical skills and a sound grasp of engineering and design principles. Analytical ability, problem solving and the critical evaluation of a design problem were felt to be promoted as much by involvement in the design process as by the academic elements of the curriculum. The conflict, in practice, was not between the need to promote analytical skills at the expense of the creative—but between the amount of theoretical content in the courses and the provision of practical design exercises, assignments and projects in which students could 'learn by doing'. Such assignments would require students to produce a number of solutions to a given design problem, evaluate each critically and come to a decision as to the most appropriate, taking all given factors into account. Some lecturers took students to outside design exhibitions, where they could build up a viewpoint on what constitutes good design. Individual contact with practising industrial designers was also helpful, when it could be arranged.

The general view was that a suitable balance had been achieved, although tutors were concerned to introduce even more practical work and design office time into the course, and to develop exercises and activities more specifically focussed on promoting design creativity.

Small-Team Approach

Tutors were in agreement that the ideal was a 'small team' approach that facilitated the high degree of integration felt necessary to ensure that the course met their aims and objectives. These could be summed up in the words of the Consultative Document – 'a good basic engineering knowledge, some practical experience, imagination and creative skill, and good draughting ability. (The designer) will have the ability to progress from work on a drawing board to the important role of supervising others engaged on design or of specialising in particular areas or subjects.'

In courses operating with a larger team, a 'central design team' usually emerged, consisting of two or three lecturers who had usually played a significant part during the planning stage of the course and, importantly, held a similar 'design philosophy'.

Successful design tutors were seen to need a clear vision of the design process, its function in industry and the learning needs of young technician designers. They require the ability to work well and unselfishly with their colleagues and to establish good liaison with other subject lecturers and with employers. They need to be capable of teaching in more than one subject area, and of integrating subjects through common assignments. They must be able also to find projects which are not only vehicles for assessment but learning opportunities for students.

In pursuit of integration, design team members might teach interchangeably; be jointly available in project sessions; cooperate closely over course content and timing. Design tutors might also teach mechanical science, manufacturing technology or other supporting subjects. Being taught by the same lecturers with the same design philosophy, these subjects will naturally become more integrated into the course's design core.

On the purely practical level, good liaison is facilitated by factors such as lecturers being in the same department and sharing adjacent offices which are located close to the main teaching rooms and drawing office.

This resulted in a workable 'team teaching' approach—but not to be interpreted in the classical sense of more than one lecturer being in the classroom at once. This new format was felt to be one of the chief characteristics that differentiated engineering design courses from the other forms of engineering education available for technicians.

Student-Centred

The design courses form part of a general movement away from the traditional teacher-focussed learning methods, the 'chalk and talk' of earlier generations, towards a more student-centred approach, in which the lecturer is cast more in a tutorial and advisory capacity than as a fount of knowledge. This has naturally led to a closer relationship between lecturer and student, which was held to be beneficial.

In the context of technician education, the design courses could be held to be innovative in various ways. Firstly, they appear to have departed from the classical emphasis on underlying principles to a greater stress on application. Traditional lecturing methods, with the student as a passive learner, have given way to increased opportunities for active learning through project work. The courses have also led to the introduction of a wide range of teaching methods, such as seminars and discussions, team assignments and group and individual exercises.

The change in teaching methods has been welcomed by employers who had day-to-day contacts with the students. Many employers had been uneasy in the past about what they saw as the excessive emphasis on theory characteristic of earlier college courses. One chief designer gave it as his opinion that 'I have always thought that college courses were too academic, with insufficient application.'

Student Reactions

Like the employers, the students welcomed the new teaching techniques—many of them compared the course favourably with what they had heard of other engineering courses. The more important role played by the student himself and his individual efforts was felt to increase motivation. As one of them said, 'It is different from other college studies. There are assignments, more applications and hands-on experience'. The courses were regarded as being particularly successful in providing students with a formal foundation in design principles and methods (which they might not otherwise receive). Students felt that the courses had been helpful in developing their problem-solving capacity, their ability to apply theory in practical situations, their communications and information-seeking skills and creativity. They had also enjoyed the computer and CAD studies.

This apart, they appreciated the direct and obvious relevance of the course to the actual jobs they were doing in industry, and the continuous assessment methods which they felt were fairer than the end-of-course assessments experienced on previous TEC courses, even though a great deal of out-of-college effort was called for. But it is only fair to add, on the debit side, that a few students would have welcomed more lecturing help before the assignments took place, and one or two, who were hoping to progress onto a degree course, felt that they would have profited by a greater emphasis on more academic subjects like mathematics and mechanical science.

Project Management

The forms of assessment used on the courses were mainly phase tests, assignments and projects. Though, as pointed out above, these were welcomed by the students, they were felt to place extra demands on the staff because of the need to use qualitative rather than quantitative criteria, to introduce team projects and to devise or select examples which were appropriate to technicians. The employer-based, end-of-course projects also caused assessment problems for the staff because of the need to take account of the amount of in-company help provided and to maintain comparability between different projects. The role of the TEC moderators has proved to be crucial in the overseeing of the design courses.

In some subjects, where great dependence has been placed on assessment

by assignment, both staff and students identified a need to introduce one or two phase tests to provide feedback on students' progress and grasp of principles, and to evaluate individual performance within a team situation. It was generally agreed that the courses should reflect in-company needs for students to be able to apply principles and to seek out information to solve problems, rather than to assess in-depth knowledge of a topic. As a result, some mention was made of using 'open book' techniques during phase tests, although the extent to which these were actually being employed was not established.

The design courses were unique amongst TEC engineering programmes in requiring students' assignment and project work to be collected together in a portfolio (as is common practice in art and design courses) for yearly assessment by TEC moderators and as a record of students' work which could be used at promotion and job interviews.

Implications for other TEC Programmes

On the engineering design courses, tutors have been forced to depart from traditional subject divisions and to face the problems of course integration and staff cooperation squarely. Valuable insights have thus been provided into the difficulties encountered by such attempts. One of the main lessons to be learned is that a significant degree of curricular integration can only be achieved by excellent organisation arising from strong but flexible central control by the course tutor. A certain flexibility is required because of the often complex inter-disciplinary teaching schedules. If there is disruption at one point of the course timetable, the whole programme is put in jeopardy.

Two possible solutions present themselves. The first is to have a large teaching team and so spread responsibility for continuity amongst its members. However, large teams tend to be unstable and there is greater difficulty in maintaining integration. The second and preferred method is to adopt a small-team approach, with team members who are able to work well with one another and to teach across subject boundaries.

Such professional skills have not in the main been called for in FE, where traditionally there has been a policy of appointing subject specialists rather than those with a breadth of knowledge and skills. Teaching training has been directed towards equipping the specialist with the well-tried lecturing methods thought appropriate to teach the principles of his subject within the standard classroom or laboratory environment. Relatively little emphasis has been placed on training for flexibility of approach, adaptation of subject material to meet inter-disciplinary demands and the use of student-centred learning techniques which recast the lecturer primarily as a skilled helper and adviser.

In-service staff development is an obvious avenue for supporting new approaches which require new sets of skills. It was interesting to find,

however, that senior staff did not perceive staff-development needs for the design courses in this broad sense but rather in the more limited context of keeping lecturers abreast of recent technological advances in industry. These latter needs should not, however, be underestimated since, without recent experience of industrial practice, there is a danger that engineering staff lose their practical ability and become too academic.

Relationships between Employers and Colleges

Before the launch of the design courses, college staff had taken considerable trouble to elicit the views of employers on the proposed content of the new programmes and their likely degree of acceptability to industry. It appears however that, in the main, consultation had taken place only with companies with which relationships already existed, these being mainly medium to large firms which were accustomed to releasing students for higher technician education.

With the exception of a few larger companies represented on design-course or TEC programme committees, there appears to have been relatively little direct contact between colleges and industry while the courses were running, apart from written communications in connection with student progress reports. Employers were not providing specialist lecturers, as anticipated in the TEC Consultative Document, nor were they furnishing material for data files and case studies on a regular basis, although tutors felt that there might be more involvement on both these levels in the future. Neither party considered, however, that industrialists had a major role to play in the classroom.

As in other engineering courses, employers tended to feel that colleges did not understand their needs and tended to keep them in the dark. College staff, on the other hand, asserted that employers did receive information but failed to assimilate or be interested in it, and hence tended to be several years behind in their awareness of courses servicing their needs.

However, better liaison did appear to develop as a result of discussions over the selection of end-of-course projects, in which considerable employer interest had been generated. Some further help from tutors appeared necessary to ensure that employers' project selections were viable in terms of student capacity and time allocated. The companies were in general quite willing to provide advice for their employees and to allow them to use company facilities, especially if the design was liable to prove of value to the firm; but more guidance was requested on the amount of advice employers should give.

Design Courses – Specialist or Generalist?

It is interesting to consider the extent to which employers considered the

new design courses to offer a general or a specialised engineering education and training. The majority view appeared to be that the course was not a general engineering programme that would be of direct use to technicians working in non-design-centred departments of their companies. Nevertheless, one training officer felt that the design course could give sales engineers a much better product knowledge; another one was of the opinion that it might enable production engineers in smaller companies to undertake or specify simple modifications themselves. There was a much more widespread feeling, however, that students on other technician engineering programmes might benefit from the introduction of some of the new learning and assessment approaches used on the design course, and from being given a greater knowledge and experience of the design process.

This apart, most employers of day-release students felt that the new design courses were a more specialised TEC Higher Certificate Programme than either the mechanical or production engineering schemes. They would not provide an obvious training route for employees who were not orientated towards the design office or research and development. If there was a chance than an employee might wish, or be required, to move out of the design office in the future into, for example, production engineering, then a more general engineering programme, that kept their options open, might be more appropriate.

Interestingly, the more mature TOPs students, who graduated from full-time courses, had found jobs in a range of engineering occupations and not solely in design.

Acceptability to Employers

Almost all the employers considered that the new design courses were a most worthwhile development. They praised the learning-by-doing approach, the integration of the subject matter within the curriculum, and the continuous assessment – all these three factors had had an important effect on employee motivation. Others felt that employees attending the course were able to work more on their own and to have developed a greater facility in looking up reference material. They also welcomed company involvement in end-of-course projects, though there were a few complaints that project selection took up an undue amount of time.

It was thought important to discover how employers saw the new courses fitting into their existing training mechanisms for technician designers. For larger companies, with specialised design-office apprenticeship schemes, the TEC Higher Certificate courses came appropriately towards the end of the indentured period. Nor was it a problem for more mature students. In companies which operated a general shop-floor apprenticeship scheme leading to the Ordinary Certificate, the start of the Higher Certificate design course often happily coincided with the point when

decisions were being made as to their area of specialisation. However, in one or two establishments where the design office played a less significant role in company affairs and fewer designers were required, there was some concern that attendance on the design course might result in too early specialisation before departmental staffing needs could be fully assessed.

With regard to the important question of whether or not employers would wish to send all their design-orientated apprentices or trainee design draughtsmen on to the new course, the answer was 'probably not'. In large firms, with good design-office career prospects, it was felt necessary to have a spread of expertise covering the electrical-mechanical design areas. There was still considered to be a need for some of the more intellectually able technicians, particularly those with a high degree of mathematical ability, to have well-developed analytical skills. The TEC Higher Certificate course in mechanical engineering would continue to provide a more appropriate training avenue for such staff and a better entry point for degree courses.

Future Prospects

It could be argued that the early 1980s were not a propitious time in which to launch a new set of day-release courses geared to industry: staff had experienced difficulty in attracting suitable numbers of students for both day-release and TOPS intakes. It was felt that, despite sustained publicity, these problems would continue in the future, as companies continued to cut back on their apprentice recruitment and hence on the number of students available for TEC Certificate and Higher Certificate programmes.

Tutors were also concerned about two other developments which might affect the courses' future. The first was the recent establishment of the National Advisory Body. It was difficult to foresee how a new day-release course with low enrolments might fare in any rationalisation which the Board might institute. The second change was more fundamental and related to anticipated developments in apprentice training from time-served to standards-led schemes of varying duration and open to a wider clientele. Inevitably there would need to be changes, yet to be determined, in the ways in which college provision fitted into these new training structures, if not in the nature of that provision itself.

Nevertheless, there is abundant evidence that, despite the various current uncertainties referred to above, the design courses are meeting a genuine need for both employers and employees. Whatever modifications to the curriculum may become necessary, their long-term future seems assured. At all events, the TEC Working party has welcomed the report and B/TEC has now published the scheme as being generally available (Business and Technician Education Council: *Engineering Design Guidelines and Units* December 1983). This gives a reasonably clear indication that they see a future for courses in this mould.

Board of management

Chairman

J G Owen CBE, *Chief Education Officer, Devon*

Members

J C N Baillie, *National Association of Teachers in Further and Higher Education*
J Deboo, *Confederation of British Industry*
E L Ellison, *Association of Principals of Colleges*
Association of Colleges of Further and Higher Education
R J Hartles, *Association of Metropolitan Authorities*
R Jackson, *Trades Union Congress*
J Morris, *Association of County Councils*
E Norris HMI, *Department of Education and Science*
L Rees, *Welsh Joint Education Committee*
Rev Canon George Tolley, *Manpower Services Commission*
C R Walker, *Department of Education and Science*

Observers

Dr F D Duffin, *Department of Education, Northern Ireland*
J Howgego, *Scottish Education Department*
K McWilliams, *School Curriculum Development Committee*
P C Webb HMI, *Welsh Office Education Department*

Secretary

Jack Mansell, *Chief Officer, Further Education Unit.*

Objectives

The objects for which ***The Further Education Unit (FEU)*** *is established are to promote, encourage and develop the efficient provision of further education in the United Kingdom and for that purpose:*
a) to review and evaluate the range of existing further education curricula and programmes and to identify overlap, duplication, deficiencies and inconsistencies therein;
b) to determine priorities for action to improve the provision of further education and to make recommendations as to how such improvement can be effected;
c) to carry out studies in further education and to support investigations of and experimentation in, and the development of further education curricula and to contribute to and assist in the evaluation of initiatives in further education;
d) to disseminate and publish information and to assist in the dissemination and publication of information about recommendations for and experiments and developments in further education.

Printed in the UK for FEU by Lithosphere Printing Co-operative Ltd.
203/205 Pentonville Road, London N1.

A limited number of extra copies of this report are available from

Publications Despatch Centre,
Department of Education and Science,
Honeypot Lane, Canons Park,
Stanmore, Middlesex HA7 1AZ.